

ID-O Energy Dashboard

Engaging Occupants to Save Energy

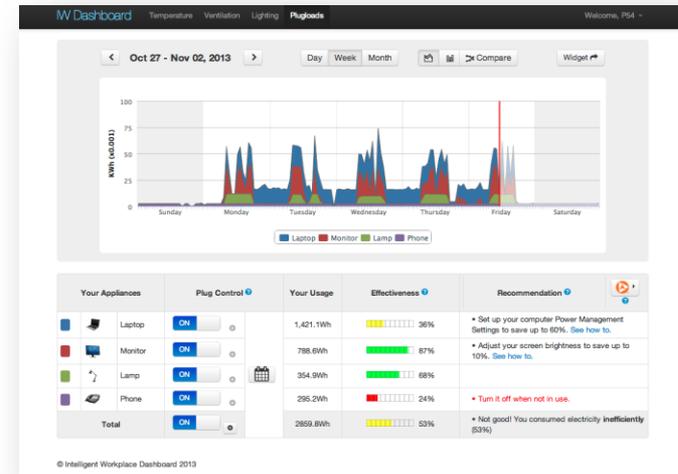
«dashboard-controllers» that enable building occupants to control energy-using components and systems with expert feedback for saving energy and increased occupant comfort

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Vivian Loftness*, Bertrand Lasternas*,

Ray Yun*, Leah Mo*, Ruchie Kothari*, Jie Zhao*

Peter Scupelli [Design], Anthony Rowe [ECE]



*Center for Building Performance and Diagnostics **Carnegie Mellon University**

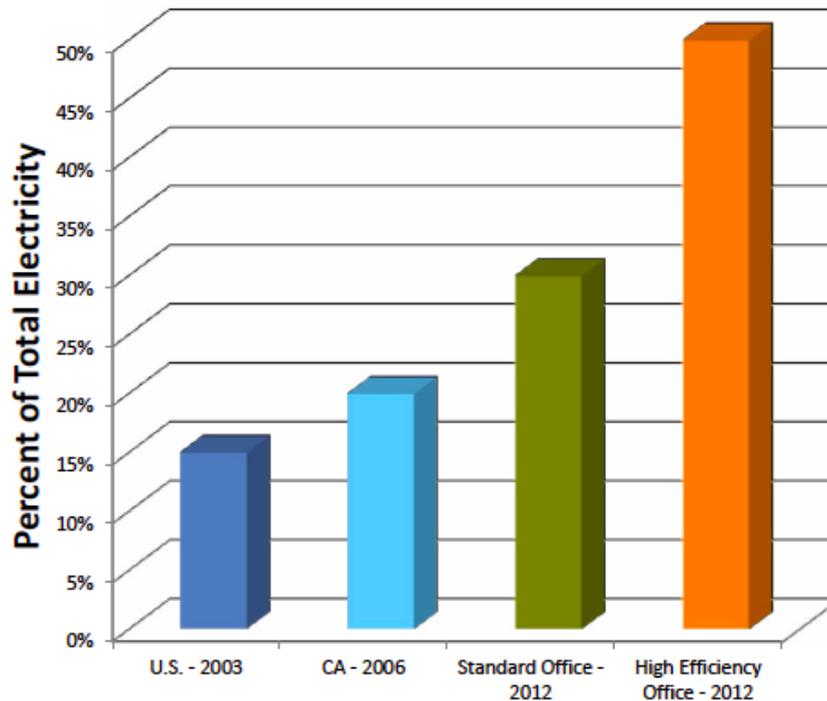
EEBHUB Year 3: Energy Dashboards for Plug Loads

Lighting, Thermal, Ventilation for Future Years

Plug load energy use for computers and office equipment is increasing. In office buildings that have improved the efficiency of lights, heating and cooling it can represent as much as 50% of the total electricity use.

Sources:
 US - Energy Information Agency
 CA - CEUS
 2012 offices - NBI Measured Data

Office Equipment Plug Loads as a Percent of Total Office Electricity

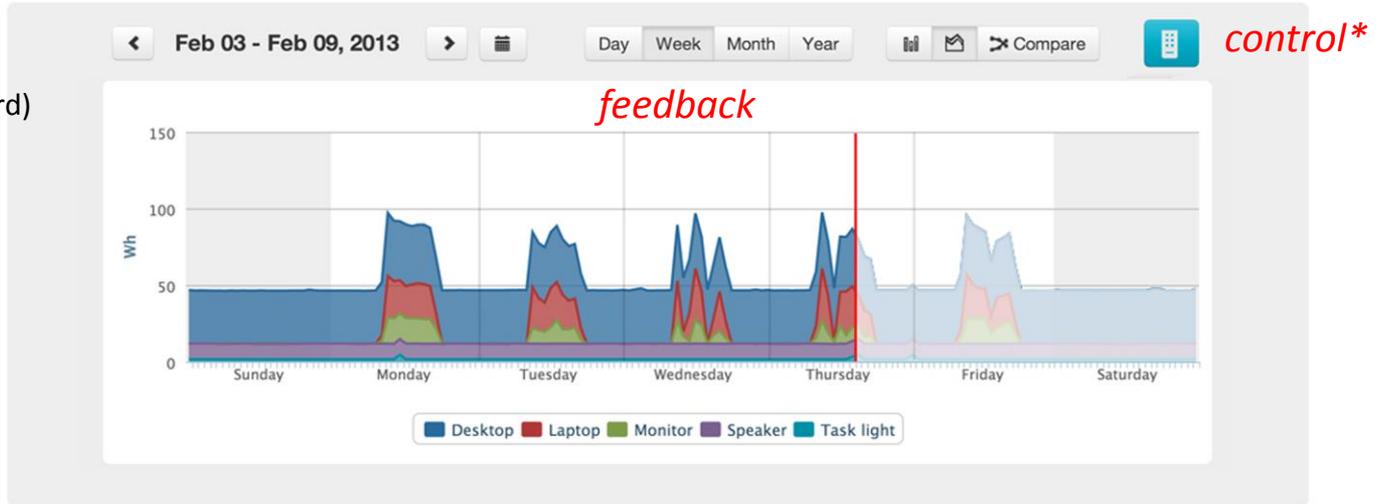


Plug Load Best Practices Guide

Managing Your Office Equipment Plug Load : NBI/Pier 2012

FEATURES

(1st generation Dashboard)




Desktop On Off

Demand: 35.1 W
Status: Active
Type: Sensitive

For a short term:

- Set up the power management. [See how to.](#)



Laptop On Off

Demand: 26.3 W
Status: Active
Type: Non-sensitive

For a short term:

- None

For a long term:

- Replace it to a top 10 Energy Star device. [Visit Energy Star website.](#)



Monitor On Off

Demand: 15.9 W
Status: Active
Type: Non-sensitive

For a short term:

- None

For a long term:

- Replace it to a top 10 Energy Star device. [Visit Energy Star website.](#)



Speaker On Off

Demand: 10.2 W
Status: Standby
Type: Non-sensitive

For a short term:

- Turn the speakers off



Task light On Off

Demand: 3.6 W
Status: Standby
Type: Non-sensitive

For a short term:

- Turn the task light off

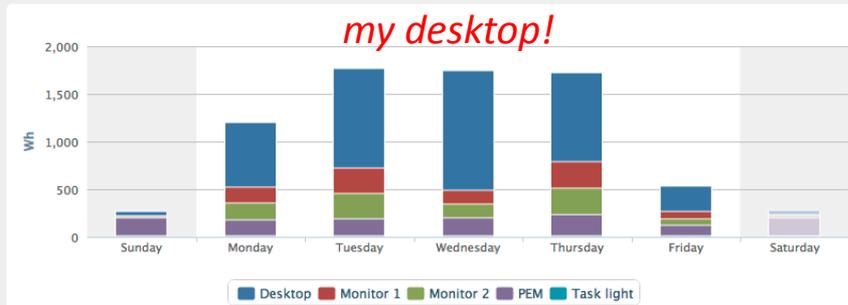
recommendation

*control**

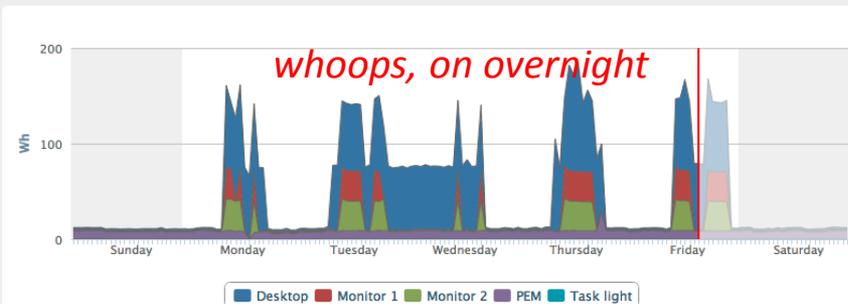
Plugloads Monitor

Etsy mixtape wayfarers, ethical weas anderson tofu before they sold out mcsweeney's organic lomo retro fanny pack lo-fi farm-to-table readymade. Messenger bag gentrify pitchfork tattooed craft beer, iphone skateboard locavore carles etsy salvia banksy hoodie helvetica. DIY synth PBR banksy irony.

◀ Sep 09 - Sep 15, 2012 ▶ Day Week Month Year



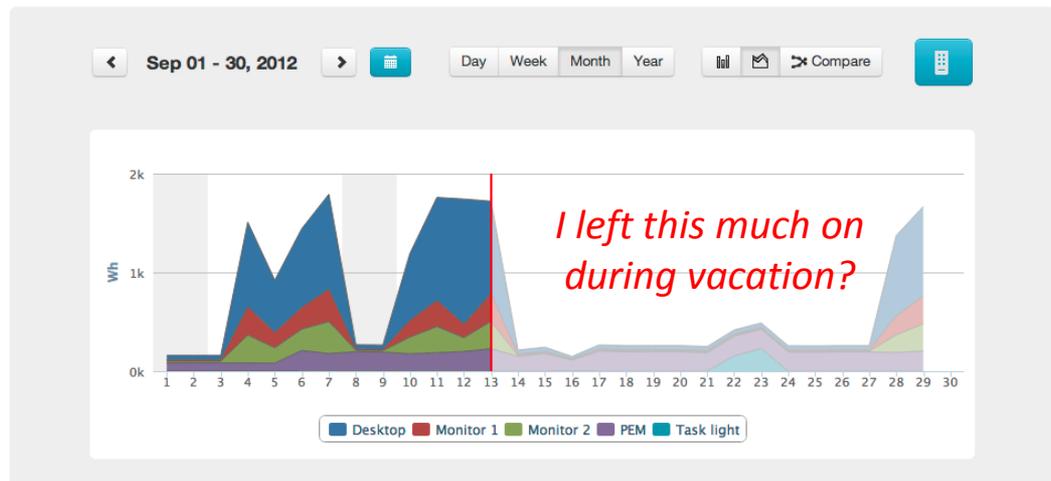
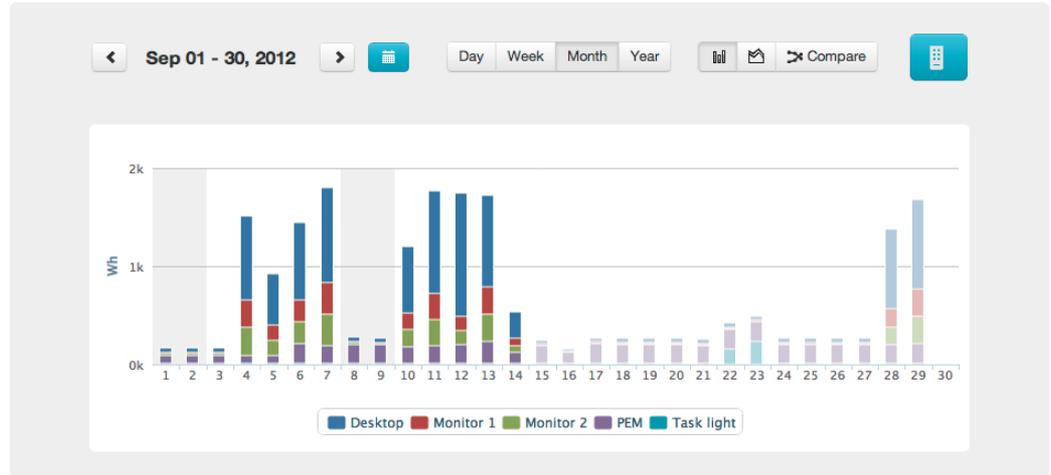
◀ Sep 09 - Sep 15, 2012 ▶ Day Week Month Year



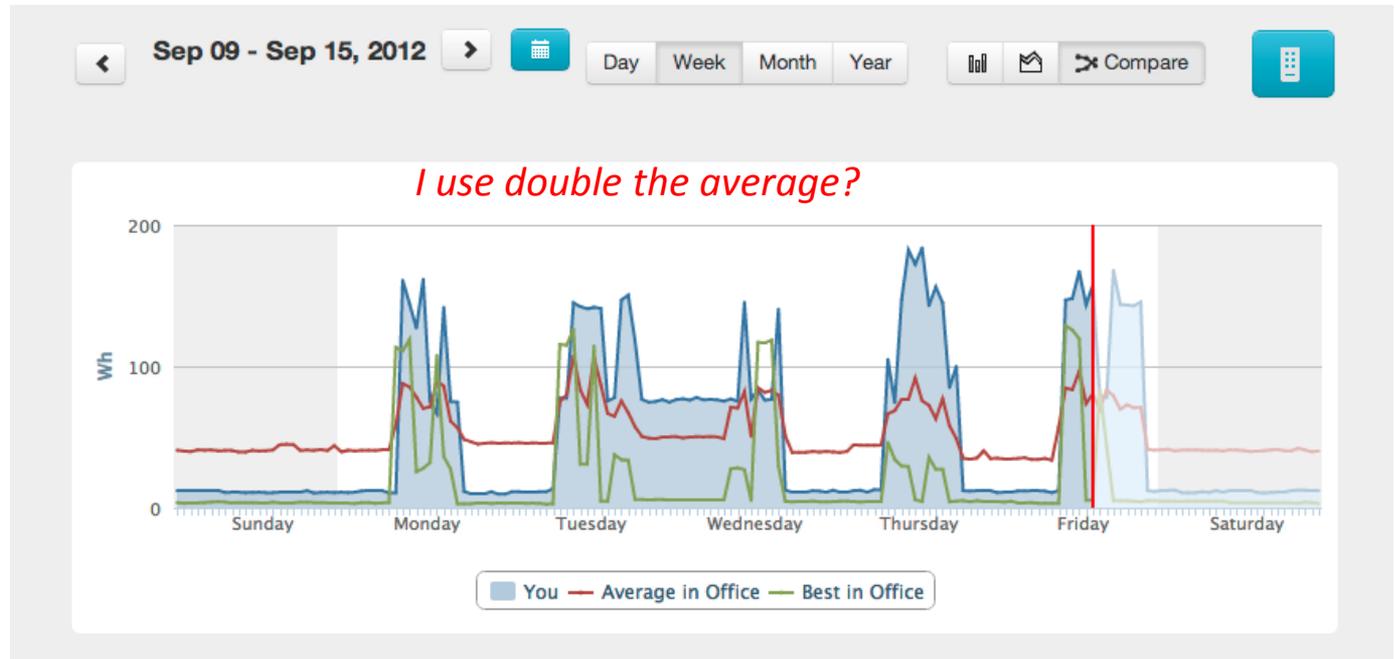
FEEDBACK
selecting the format that communicates to you

Plugloads Monitor

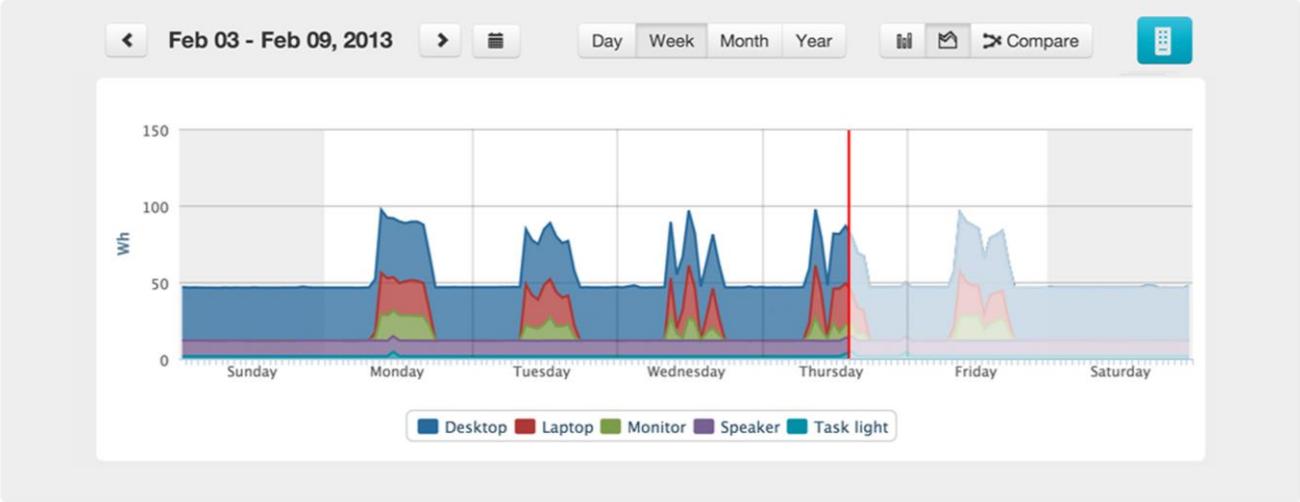
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FEEDBACK
looking a monthly consumption



FEEDBACK
checking out the competition



Desktop On Off

Demand: 35.1 W
Status: Active
Type: Sensitive

For a short term:
 • Set up the power management.
[See how to.](#)

Laptop On Off

Demand: 26.3 W
Status: Active
Type: Non-sensitive

For a short term:
 • None

For a long term:
 • Replace it to a top 10 Energy Star device.
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Speaker On Off

Demand: 10.2 W
Status: Standby
Type: Non-sensitive

For a short term:
 • Turn the speakers off

Task light On Off

Demand: 3.6 W
Status: Standby
Type: Non-sensitive

For a short term:
 • Turn the task light off

RECOMMENDATION ...
generated by expert analysis of use

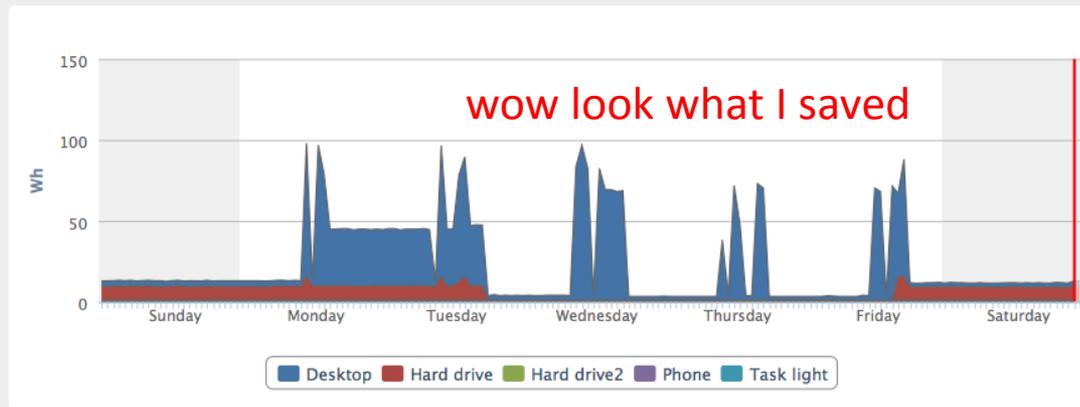
© Intelligent Workplace Dashboard 2013

Appliance	Demand	Status	Quick Recommendation	Why do this?	Control	Calendar
Desktop	2.4 W	Standby	Turn it off by pressing the 'off' button in the right hand side.		On Off	
Hard drive	0 W	Off	None		On Off	
Hard drive2	0 W	Off	None		On Off	
Phone	1 W	Off	None		On Off	
Task light	0 W	Off	None		On Off	

Demands, status and quick recommendations are automatically updated every 1.5 second

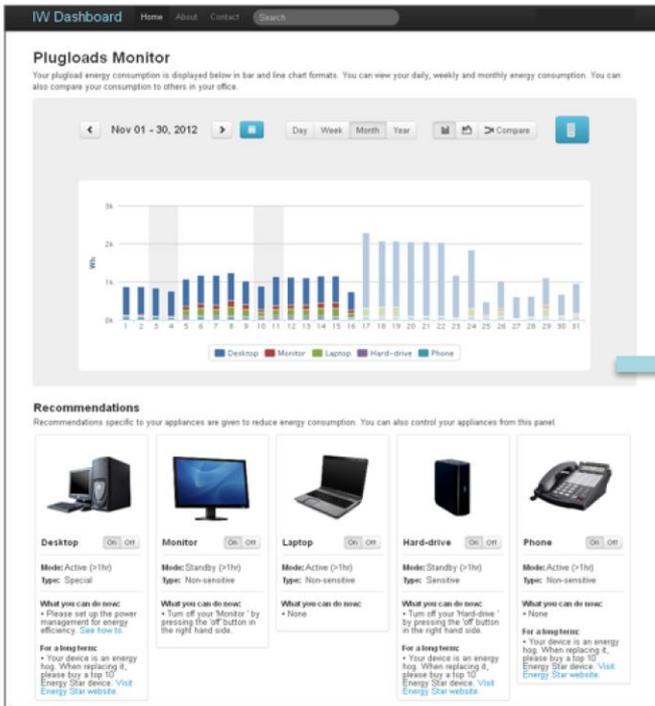
Group	Appliances in Group	Edit	Control	Calendar
(Group) Non-sensitive items	Monitor 1, Monitor 2, PEM, Task light		On Off	

← **Sep 09 - Sep 15, 2012** →
📅
Day Week Month Year
📊 📧 🔄 Compare
☰



CONTROL
*on-line, item by item
 or as a group*

Preliminary Study



1st generation dashboard (2012)



Government research lab (8)



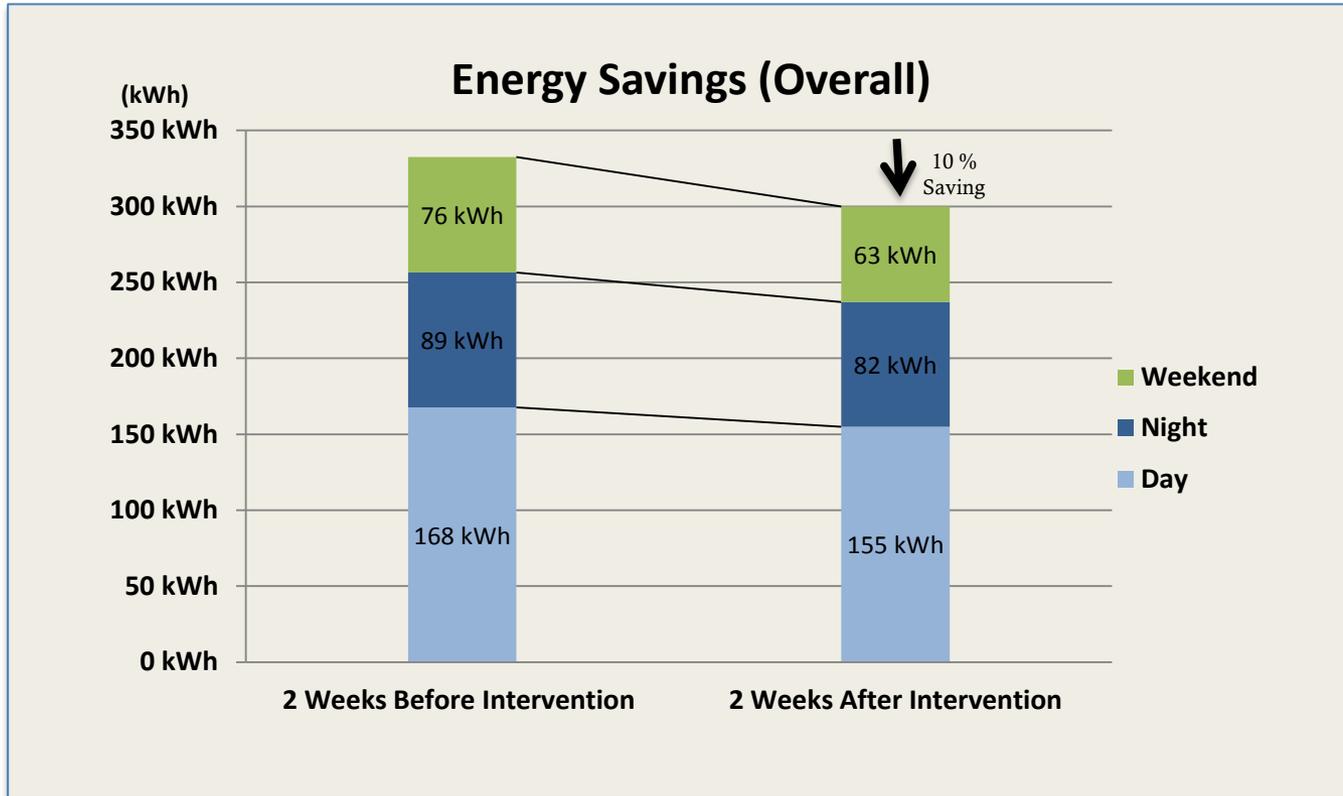
University office suite (7)



University graduate lab (6)

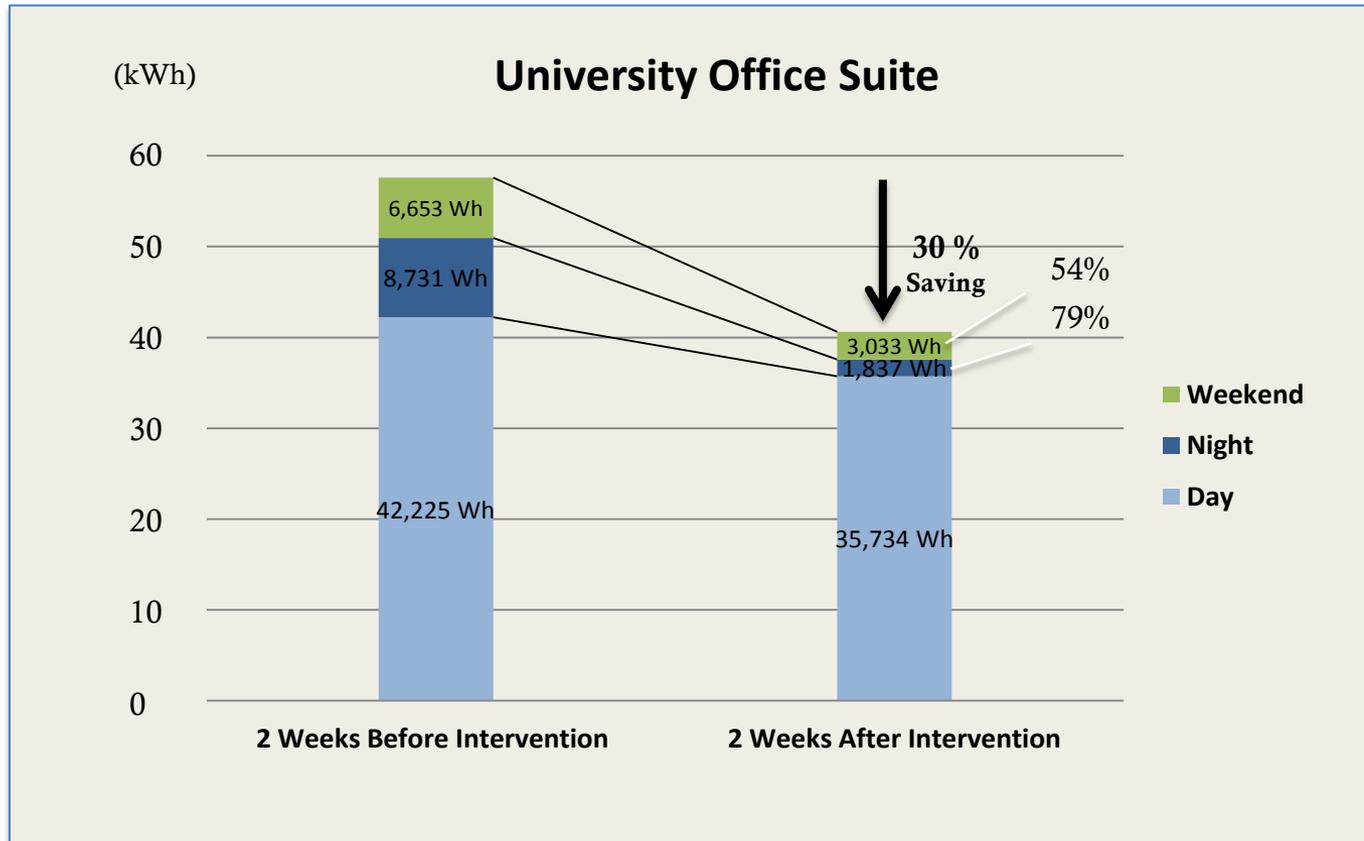
For a preliminary study, we provided our system to one government research lab (n=8), one university office suite (n=7), one university graduate research lab (n=6). We investigated the impact on Energy Dashboard on energy savings.

Preliminary Findings

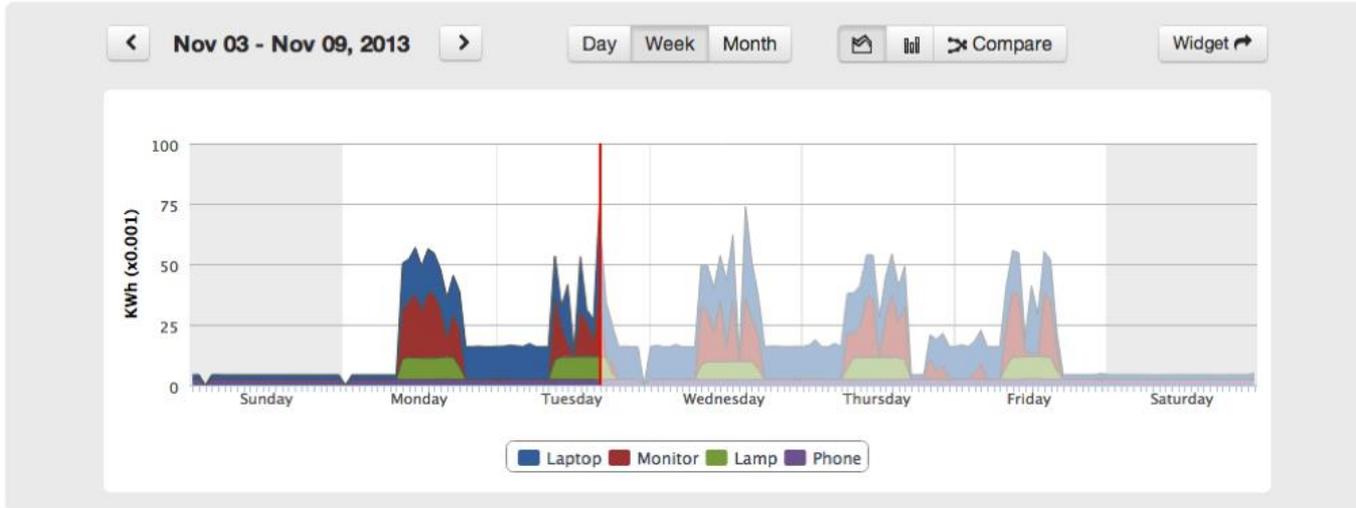


The Energy Dashboard with monitoring, advice, comparisons and controls yielded 10% energy savings overall. (*Government lab: 5% increase! With reductions in the University office suite: 30%, University lab: 31.5%*)

Best Preliminary Findings



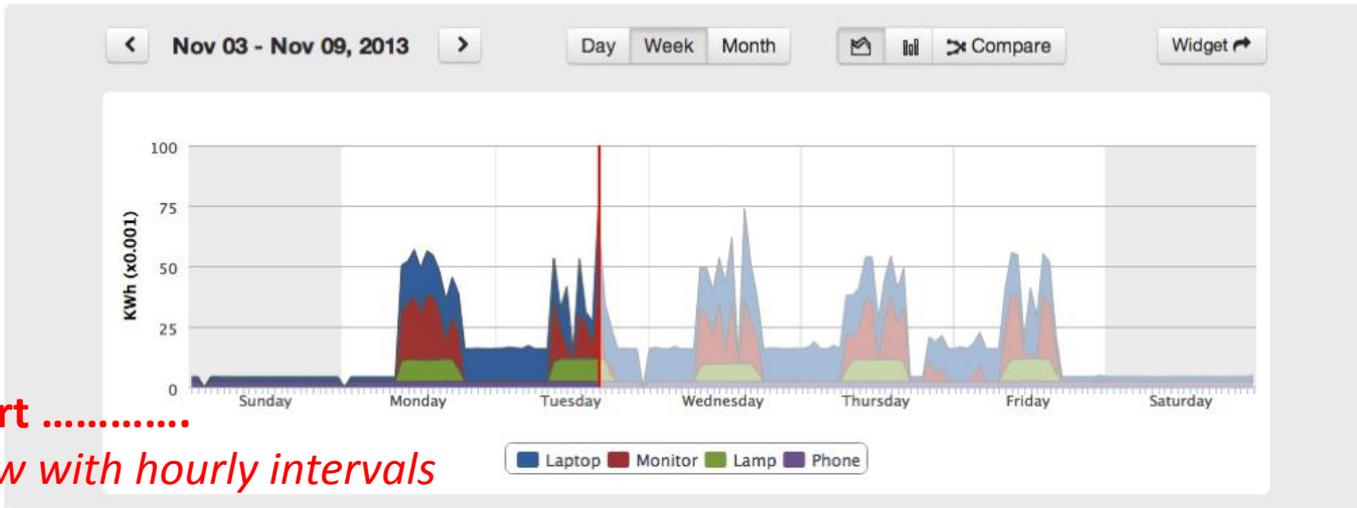
In the University Office Suite, occupants turned off their electronics more often at night and on weekends after the dashboard intervention.



Your Appliances		Plug Control	Your Usage	Effectiveness	Recommendation
	Laptop	<input type="checkbox"/> ON	501.4Wh	45%	• Set up your computer Power Management Settings to save up to 60%. See how to.
	Monitor	<input type="checkbox"/> ON	291.0Wh	100%	• Adjust your screen brightness to save up to 10%. See how to.
	Lamp	<input type="checkbox"/> ON	151.6Wh	70%	
	Phone	<input type="checkbox"/> ON	146.3Wh	21%	• Turn it off when not in use.
Total		<input type="checkbox"/> ON	1090.24Wh	60%	• Not good! You consumed electricity inefficiently (60%)

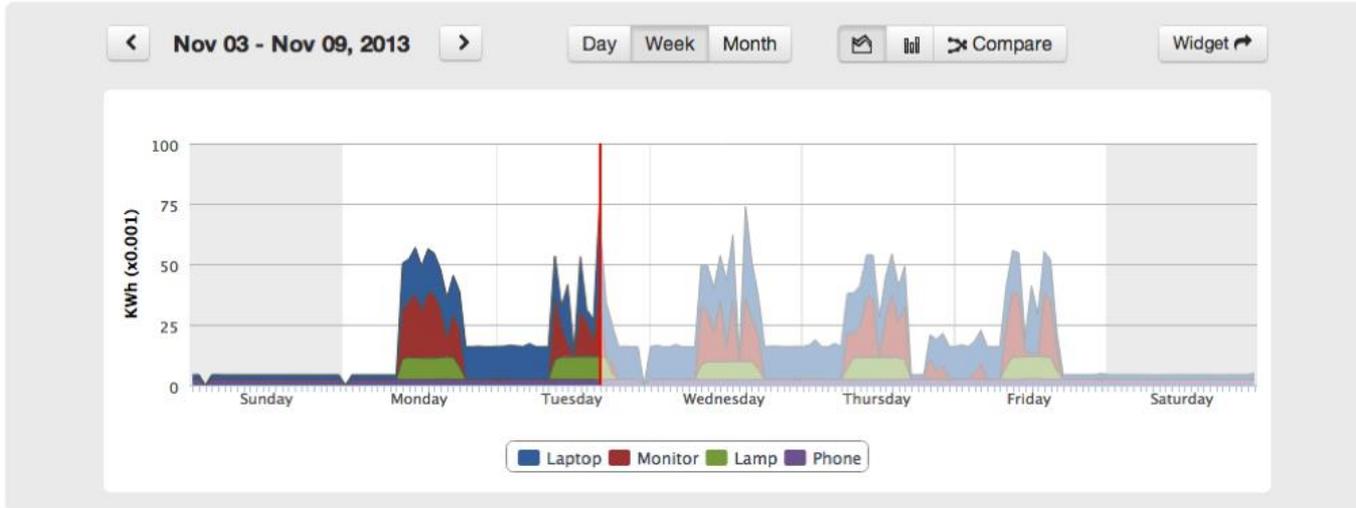
© Intelligent Workplace Dashboard 2013

2nd Generation Dashboard



Area Chart
Week view with hourly intervals
Most useful and engaging

Your Appliances		Plug Control	Your Usage	Effectiveness	Recommendation
	Laptop	<input checked="" type="checkbox"/> ON	501.4Wh	45%	• Set up your computer Power Management Settings to save up to 60%. See how to.
	Monitor	<input checked="" type="checkbox"/> ON	291.0Wh	100%	• Adjust your screen brightness to save up to 10%. See how to.
	Lamp	<input checked="" type="checkbox"/> ON	151.6Wh	70%	
	Phone	<input checked="" type="checkbox"/> ON	146.3Wh	21%	• Turn it off when not in use.
Total		<input checked="" type="checkbox"/> ON	1090.24Wh	60%	• Not good! You consumed electricity inefficiently (60%)



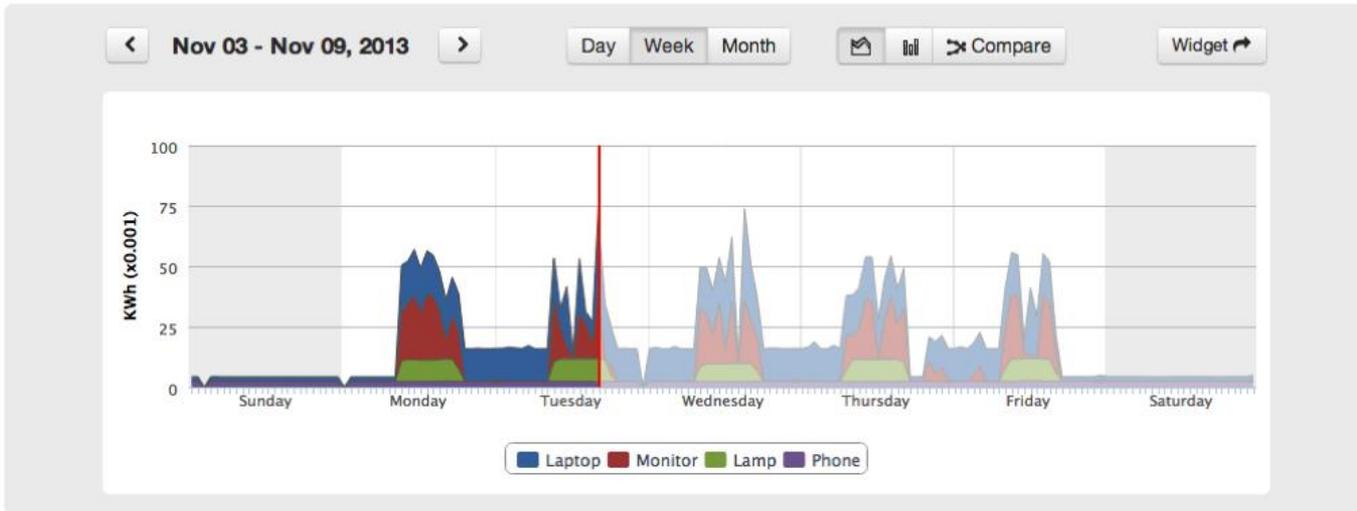
Your Appliances		Plug Control	Your Usage	Effectiveness	Recommendation
	Laptop	<input type="checkbox"/> ON	501.4Wh	45%	• Set up your computer Power Management Settings to save up to 60%. See how to.
	Monitor	<input type="checkbox"/> ON	291.0Wh	100%	• Adjust your screen brightness to save up to 10%. See how to.
	Lamp	<input type="checkbox"/> ON	151.6Wh	70%	
	Phone	<input type="checkbox"/> ON	146.3Wh	21%	• Turn it off when not in use.
Total		<input type="checkbox"/> ON	1090.24Wh	60%	• Not good! You consumed electricity inefficiently (60%)

© Intelligent Workplace Dashboard 2013

Behavior Effectiveness

Percent effectiveness for your behavior towards energy savings per device

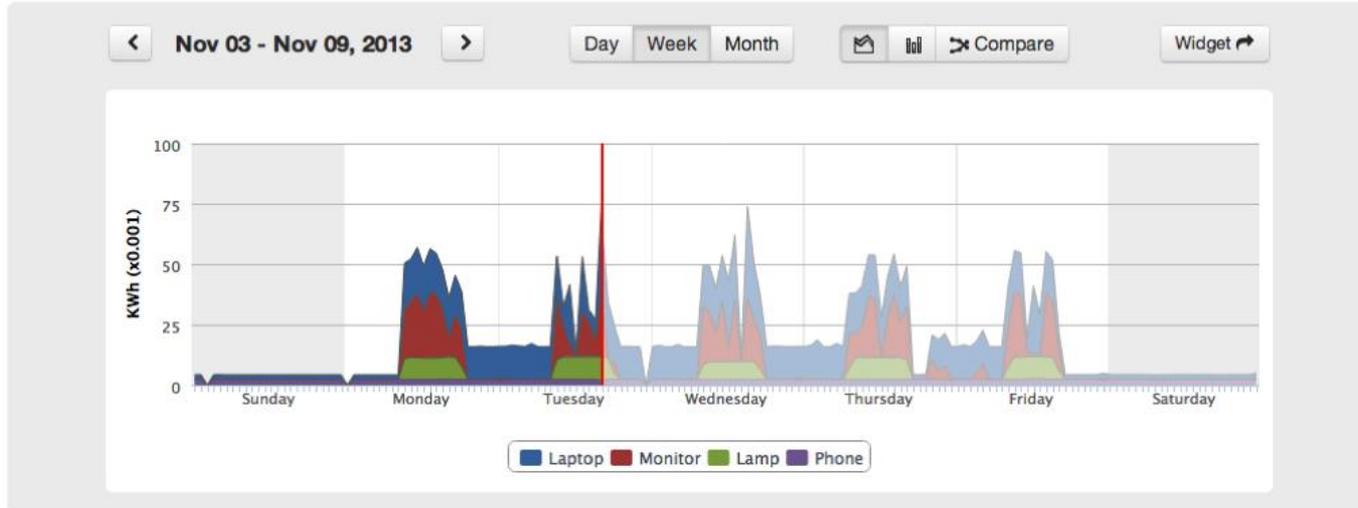
Re-energizing buildings for the future.™



Your Appliances	Plug Control	Your Usage	Effectiveness	Recommendation
Laptop	<input type="checkbox"/> ON	501.4Wh	45%	• Set up your computer Power Management Settings to save up to 60%. See how to.
Monitor	<input type="checkbox"/> ON	291.0Wh	100%	• Adjust your screen brightness to save up to 10%. See how to.
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Phone	<input type="checkbox"/> ON	146.3Wh	21%	• Turn it off when not in use.
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CONTROL
on-line, item by item
or as a group

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Your Appliances	Plug Control	Your Usage	Effectiveness	Recommendation
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Calendar
Scheduled control

Control Scheduler



(Drag it when it is ready)

1. Select control type

- Off
- On (Not recommended)

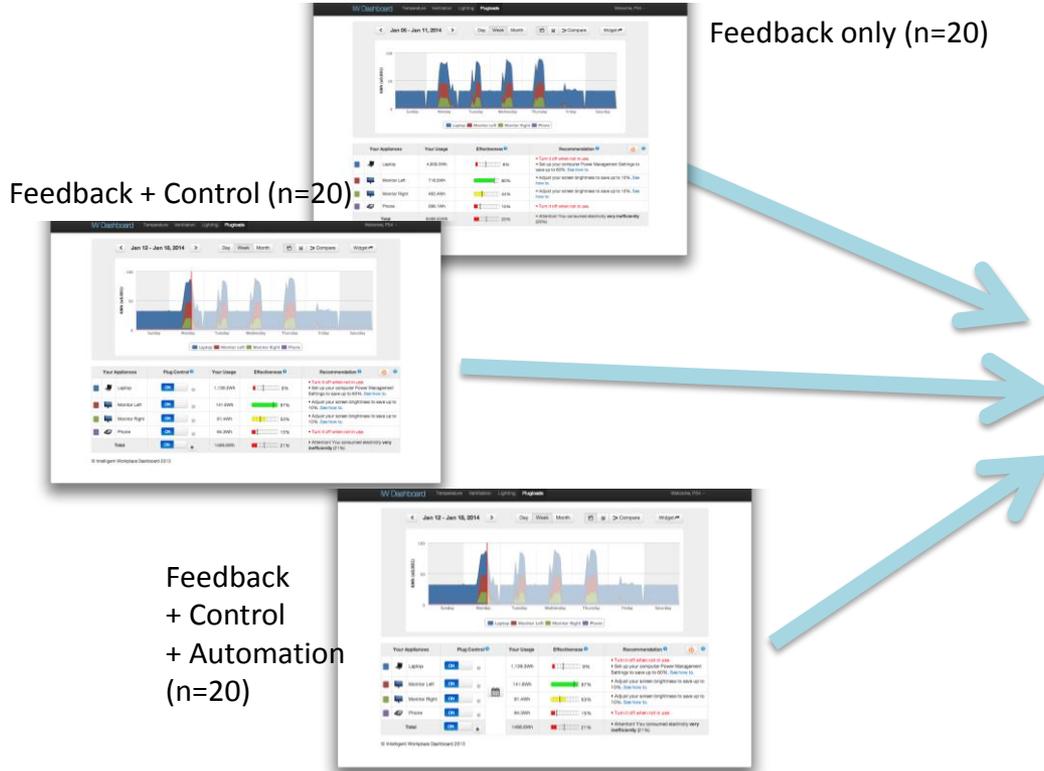
2. Select the devices you want to control.

-  Laptop
-  Monitor
-  Alarm Clock
-  Phone

3. Drag the controller to the time table.

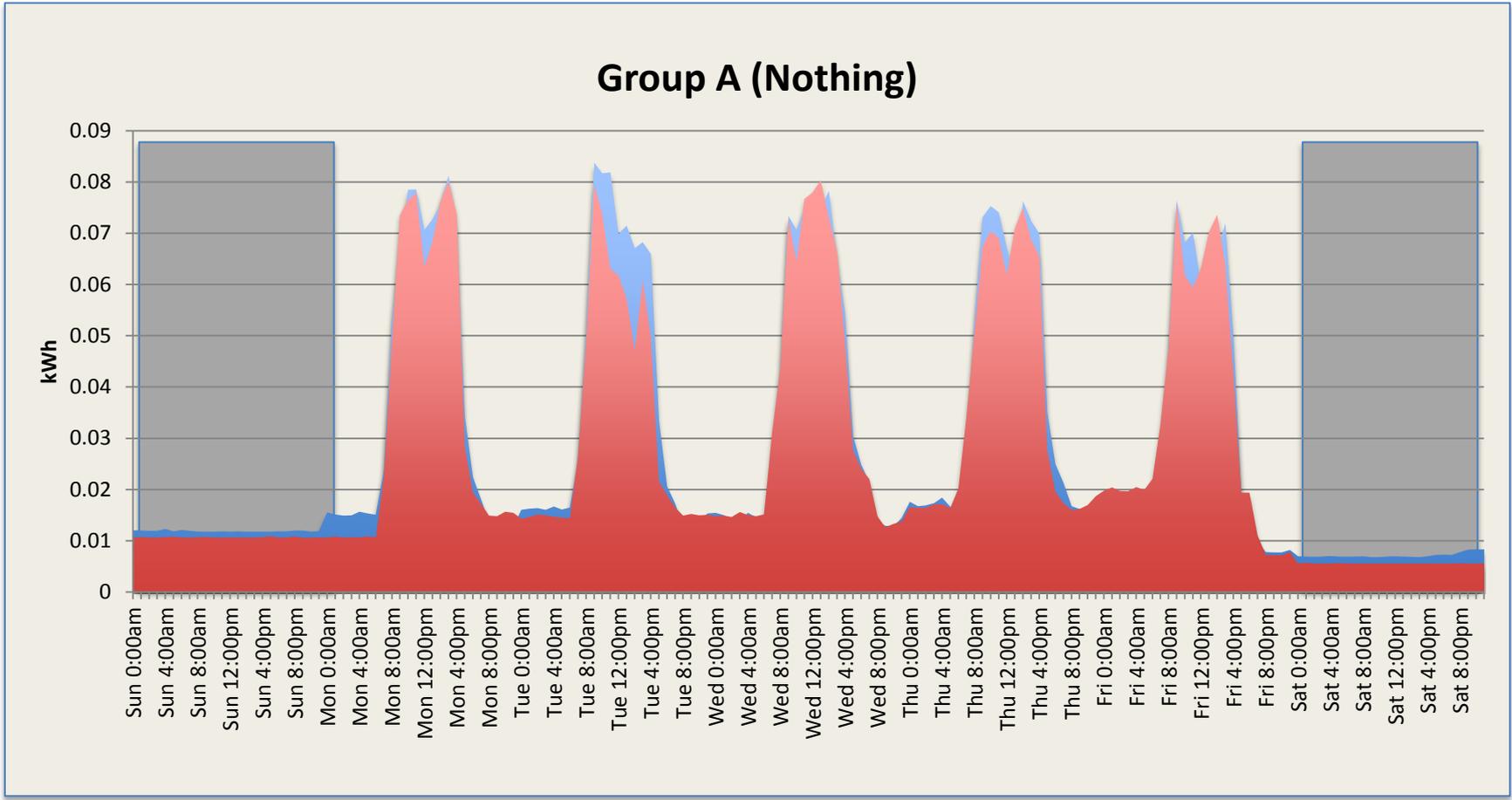
	Sun	Mon	Tue	Wed	Thu	Fri	Sat
12am							
2am							
4am							
6am							
8am							
10am							
12pm							
2pm							
4pm							
6pm							
8pm							
10pm							

Field Study



Eighty employees were divided into four groups. The first group is the control group, the three differently designed interface were assigned to the rest of the groups.

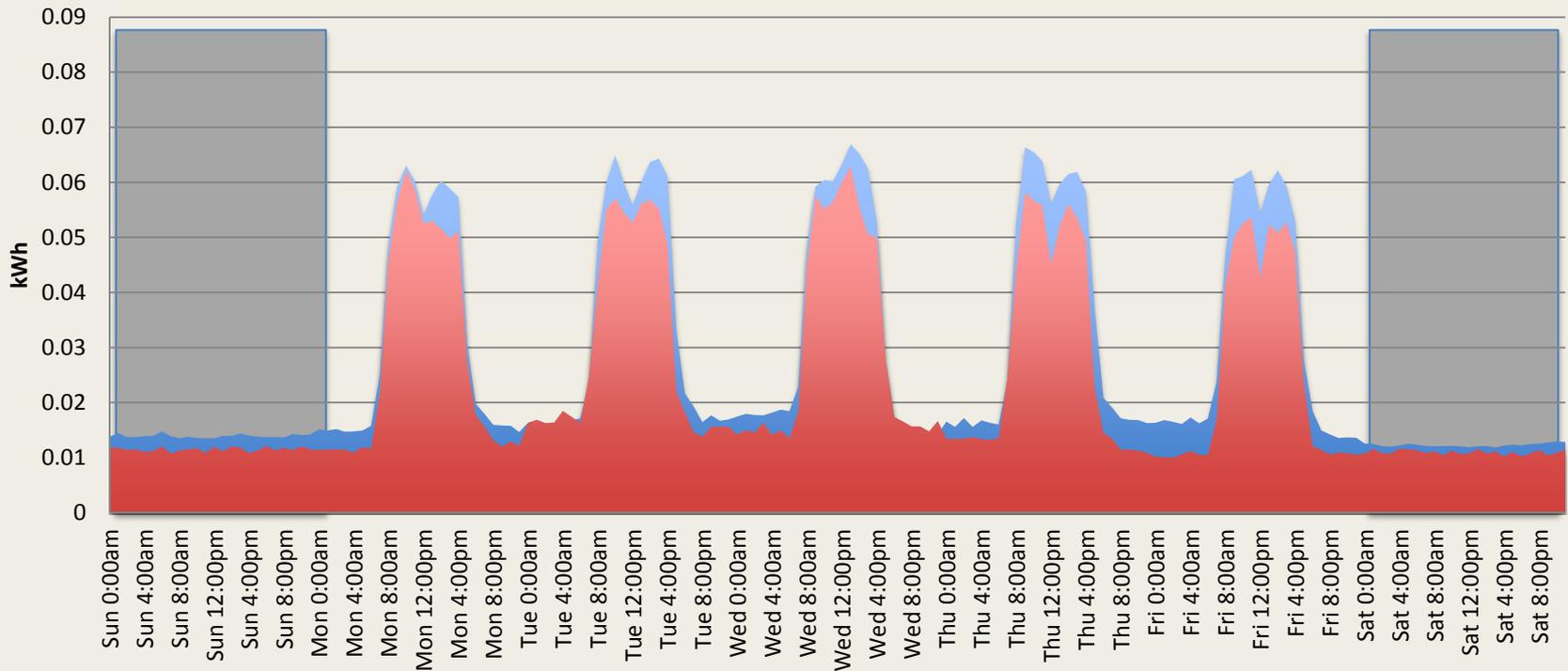
Preliminary Findings



■ Before Energy Dashboard
 ■ After

Preliminary Findings

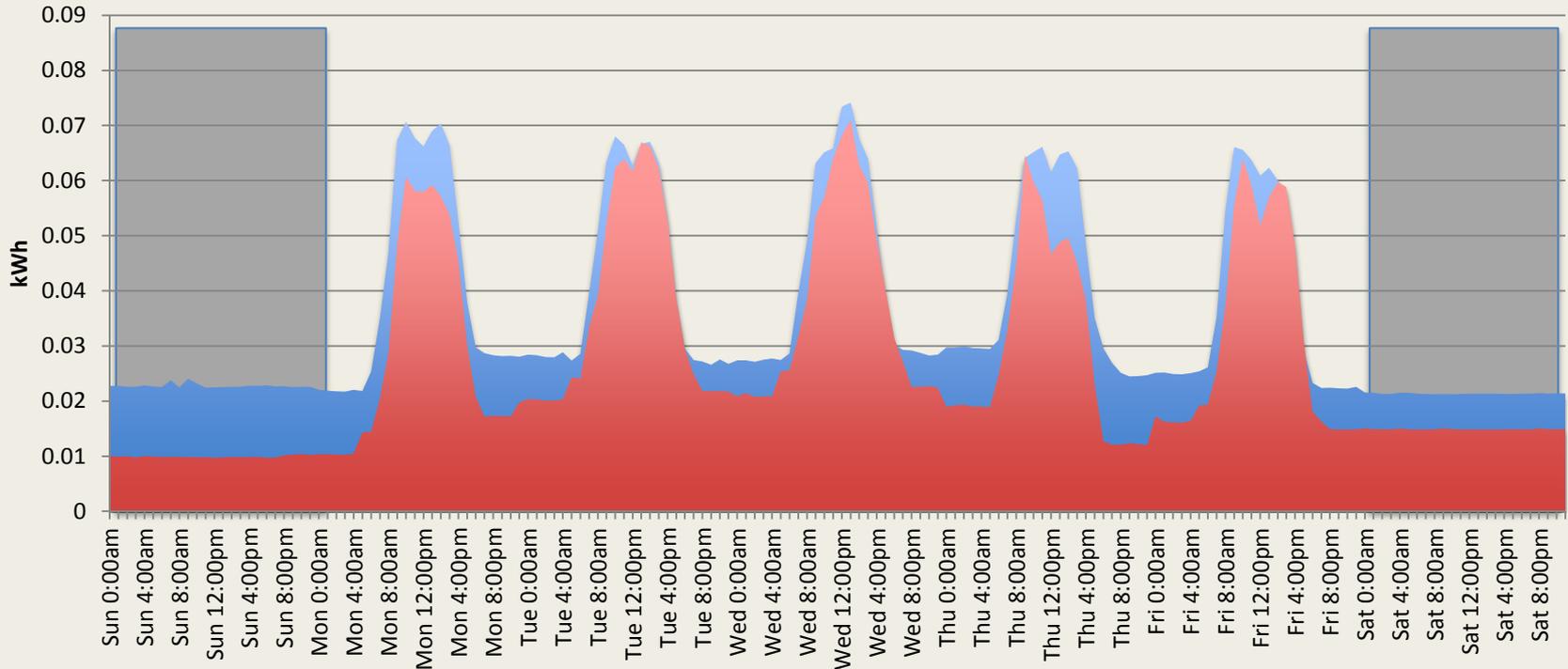
Group B (Feedback only)



■ Before Energy Dashboard
 ■ After

Preliminary Findings

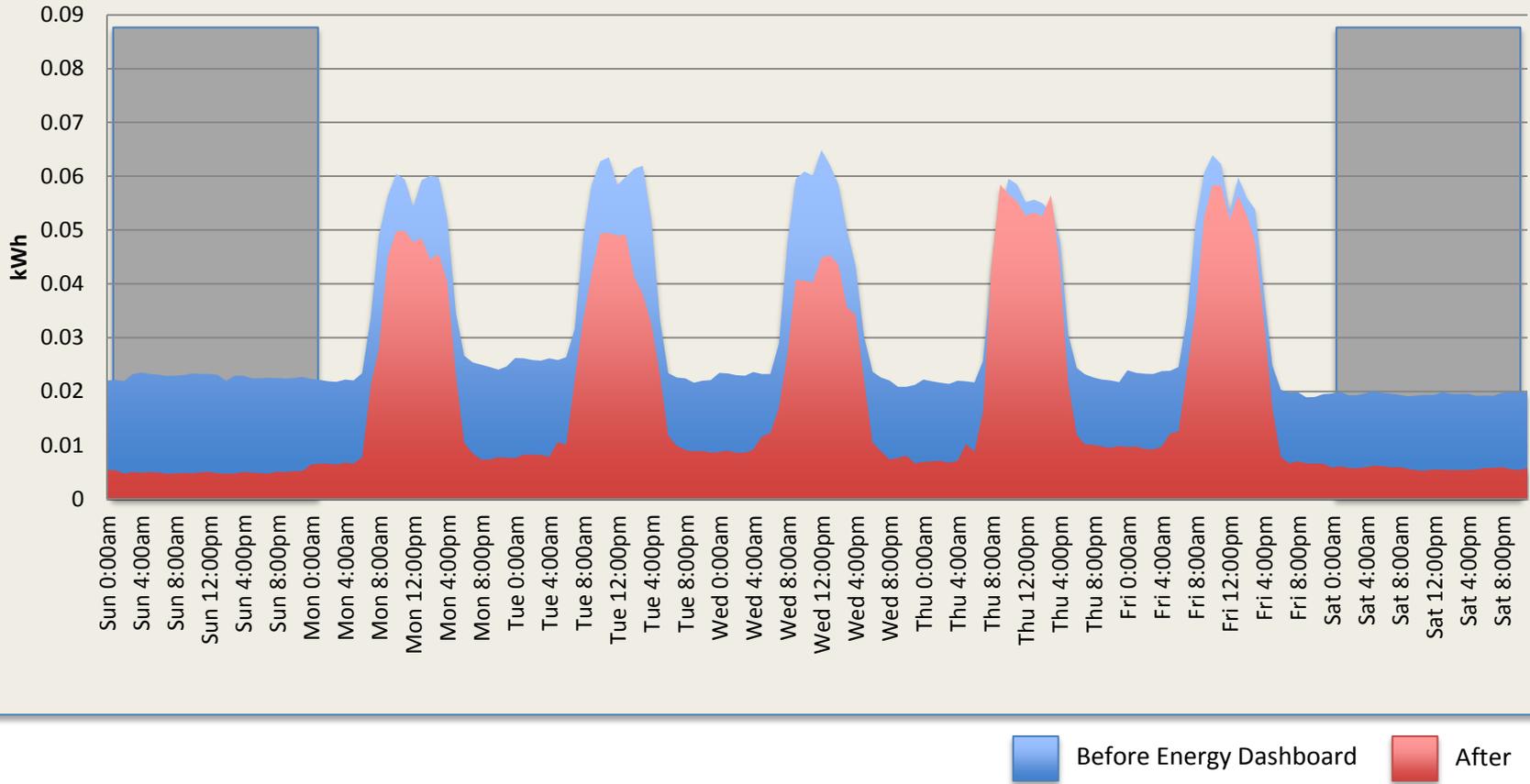
Group C (Feedback + Control)



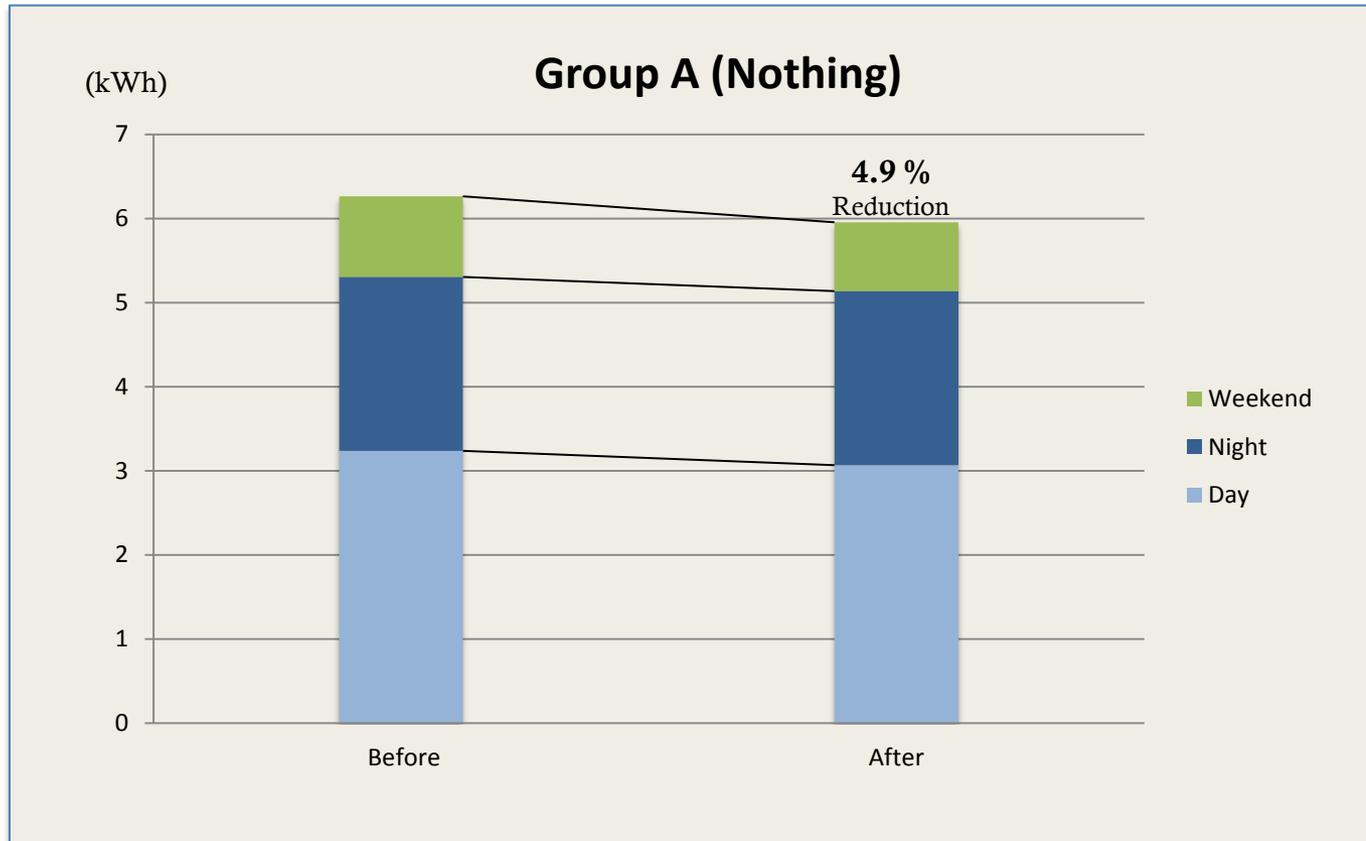
■ Before Energy Dashboard
 ■ After

Preliminary Findings

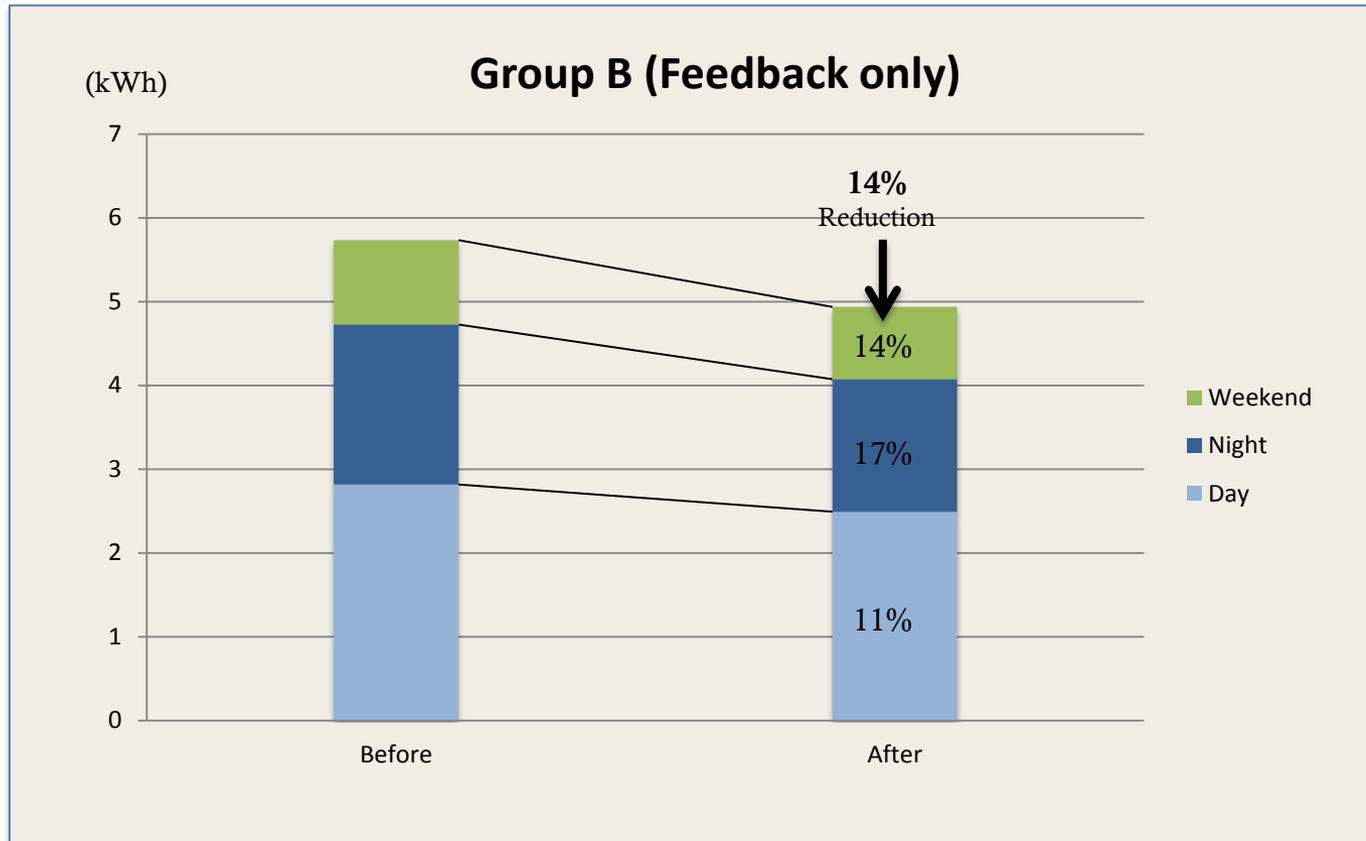
Group D (Feedback + Control + Calendar)



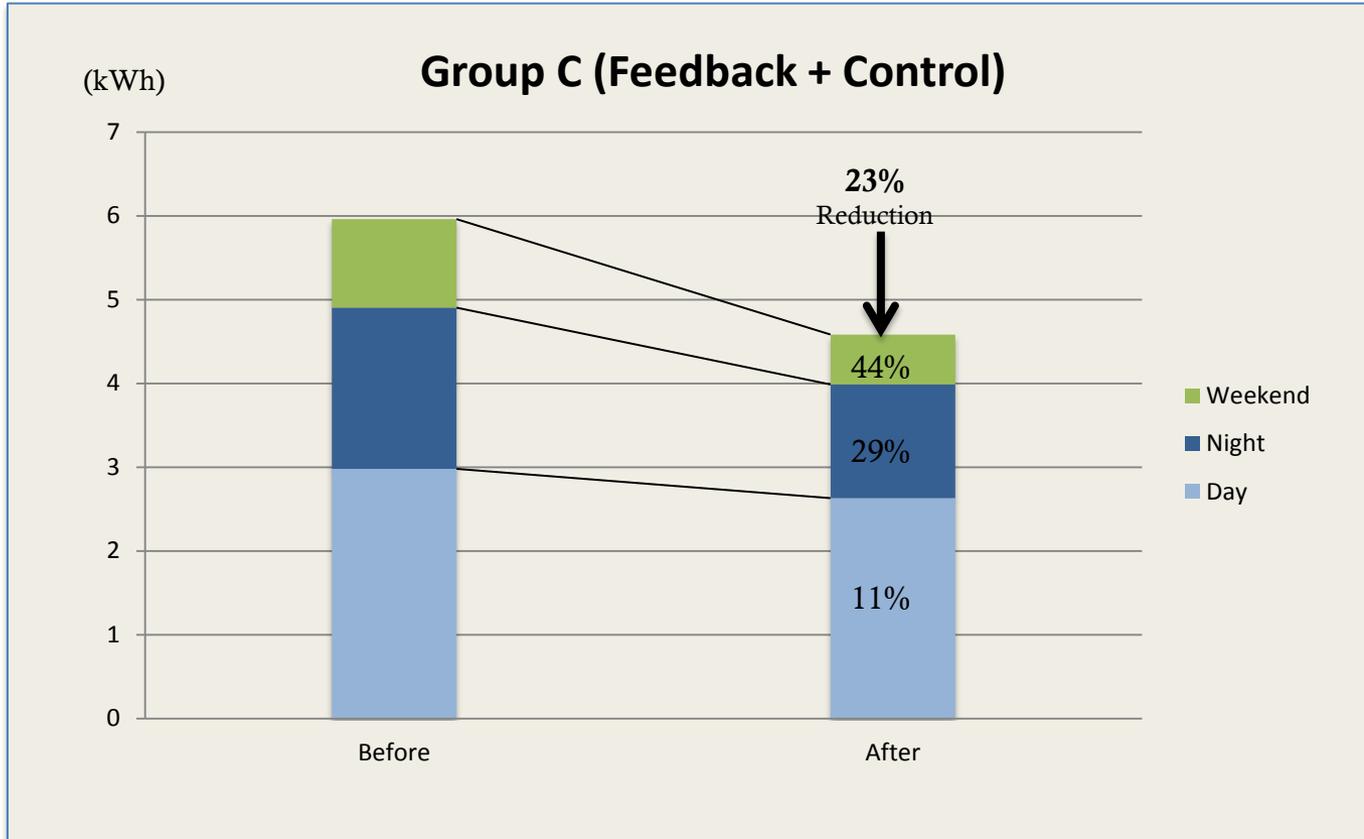
Preliminary Findings



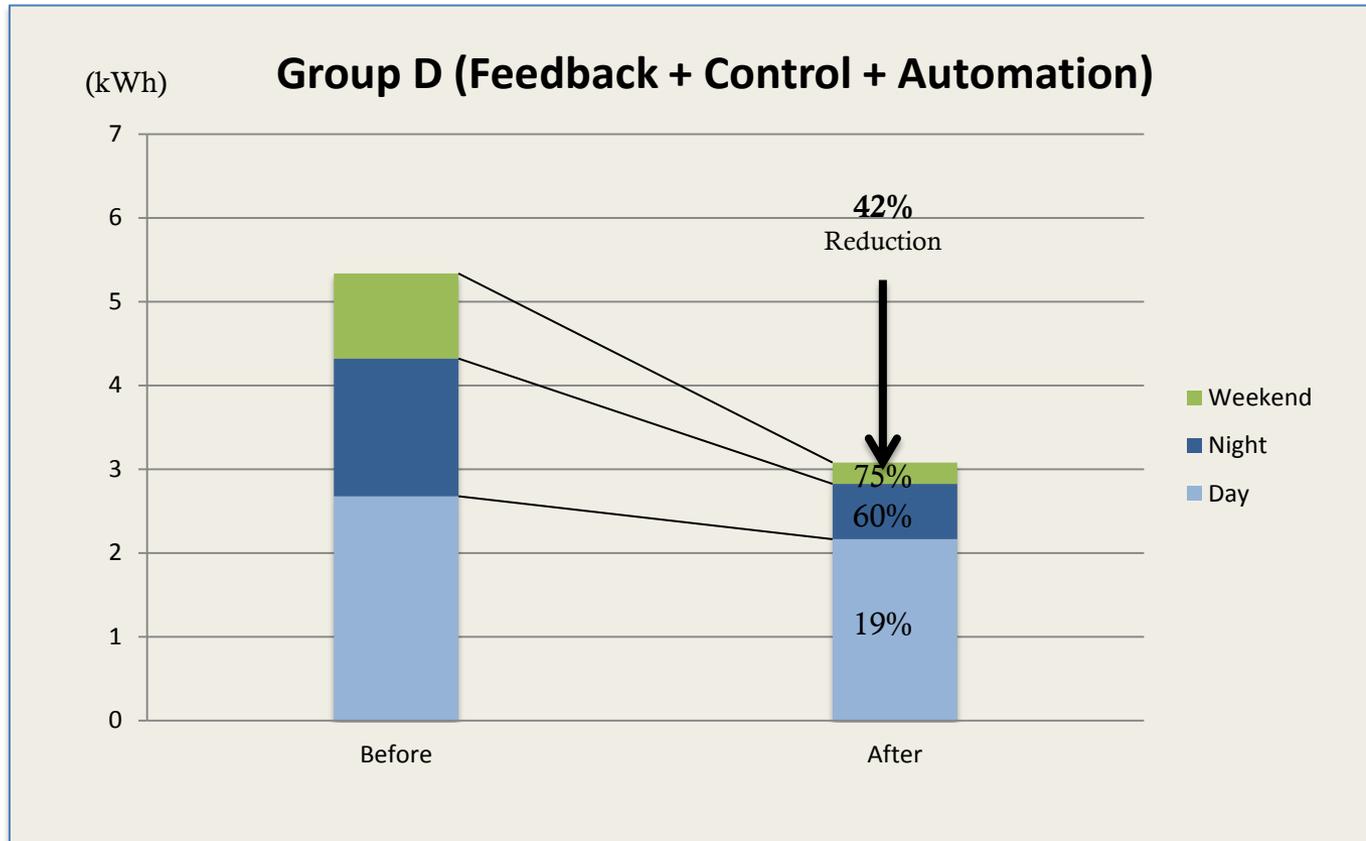
Preliminary Findings



Preliminary Findings



Preliminary Findings



Energy Dashboards Enter the Office Cubicle

Studies Give Workers Tools to Monitor and Reduce Their Individual Energy Use

By LISA WARD

Energy dashboards—tools that show consumers how much power they are using, and how to use less—are becoming more common in households.

Journal Report

Insights from **The Experts**

Read more at WSJ.com/Energy

More in Unleashing Innovation: Energy

- [Six Myths About Renewable Energy](#)
- [Unlocking an Oil Bounty in California](#)
- [Why China Is a Problem for Coal](#)
- [Utilities Connect With Social Media](#)

Can the same technology help reduce energy use in office buildings?

That's the question two separate pilot projects are hoping to answer. Researchers from Carnegie Mellon University and the National Renewable Energy Laboratory are giving so-called energy dashboards to dozens of office workers to show them, via charts and graphics, how much energy they are using at any particular moment.

Based on what they see, and the dashboard's feedback, workers can then make smart decisions about how to cut back on their energy usage.



TKIK

The dashboard used in the Carnegie Mellon study charts individual energy use by device over time.

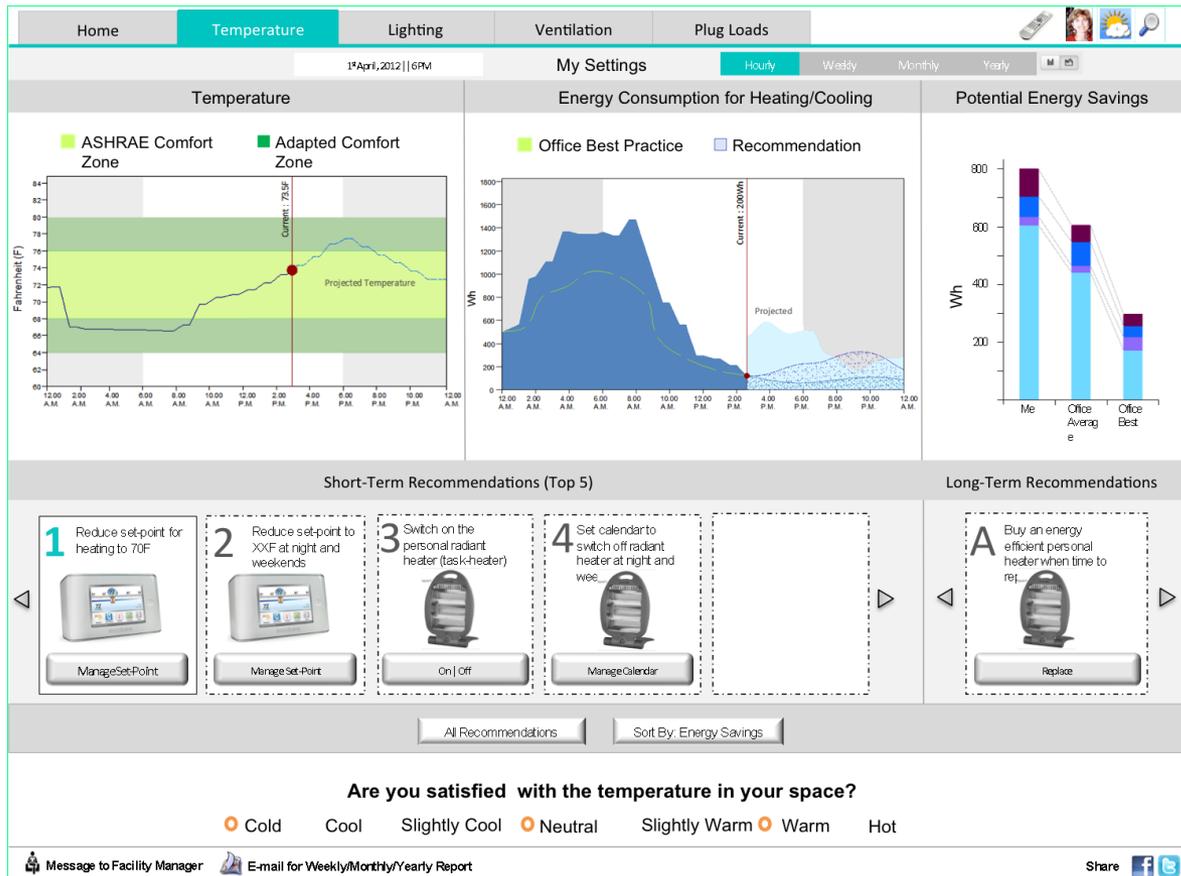
If more workers took responsibility for their own power usage, the savings could be huge. Commercial buildings account for 36% of all energy used in the U.S., according to Department of Energy. Experts believe a significant portion of that is waste; many buildings run close to full power on nights and weekends.

So far, the indications are promising. The Carnegie Mellon team found that two out of three sites in an initial small-scale study saved about 30% of energy compared with a baseline. The third site, a government research lab, showed no real savings because the lab's policy is to keep its computers running at all times.

The amount of energy employees personally have control over may grow even more in the future. Plug loads—the energy used by anything plugged into an electric socket—represent about 10% to 30% of consumption in an average office building, says Nicholas Holt, a director at the

<http://online.wsj.com/article/SB10001424127887324886704579052883651889864.html>

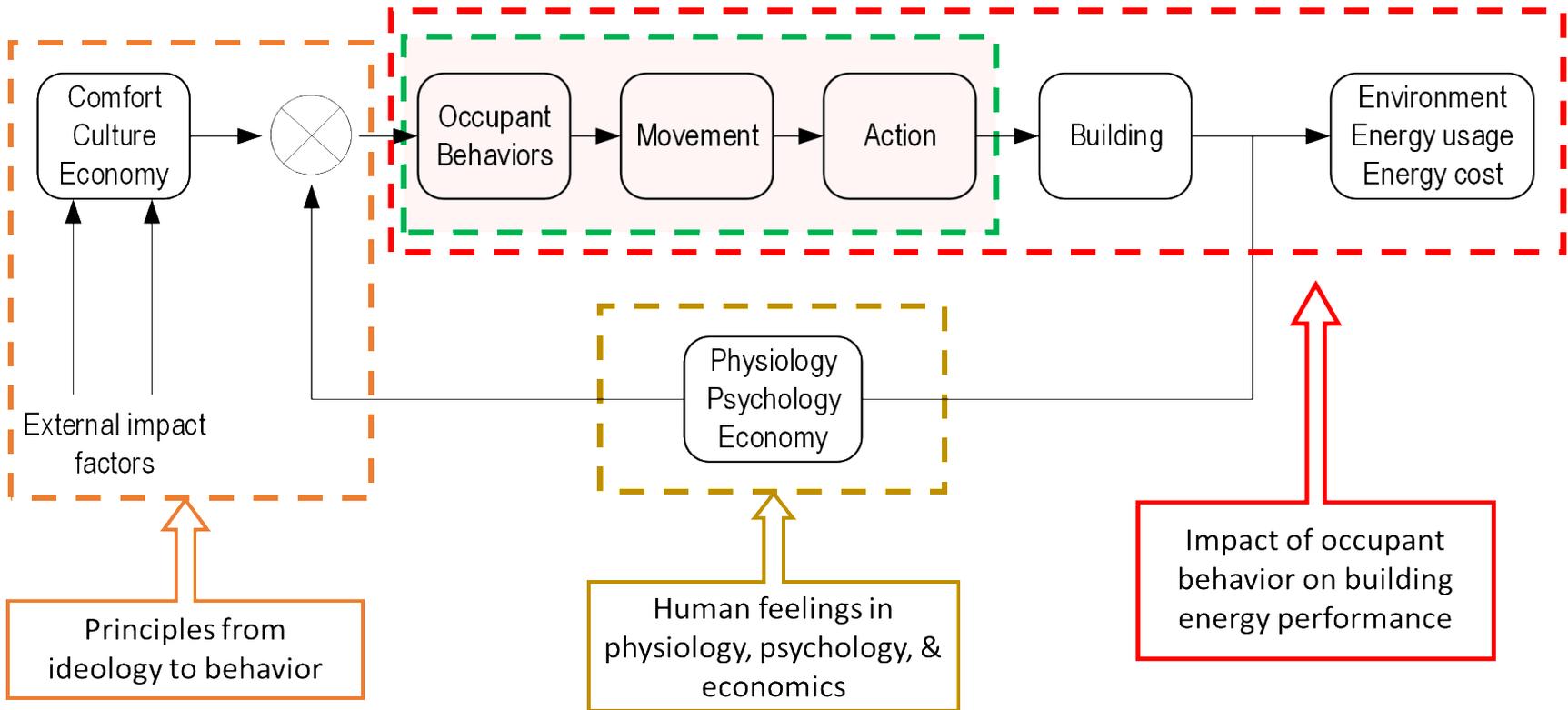
WHAT'S NEXT?



now we need to tackle the bigger energy users: heating, cooling, lighting, ventilation...
for energy conservation *and* increased occupant comfort

IEA Annex 66:

Definition and Simulation of Occupant Behavior in Buildings

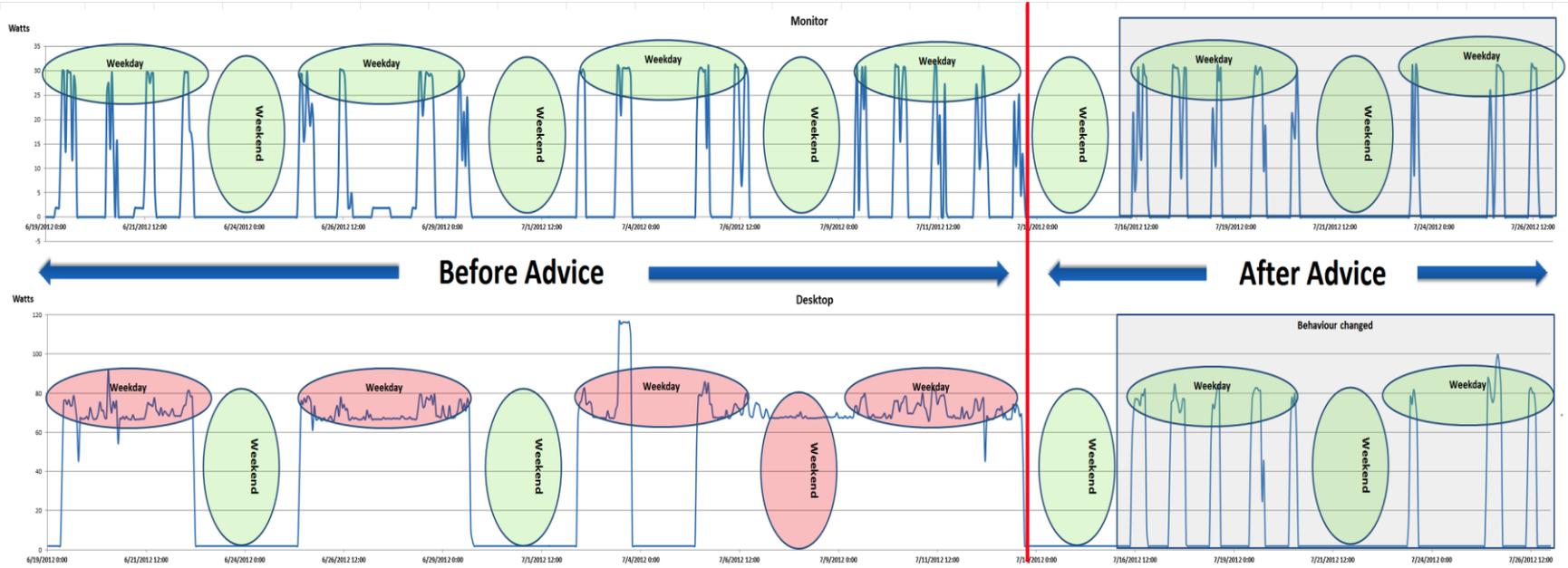


Thank You!
azizan@cmu.edu

Back-up slides



Individual Actions

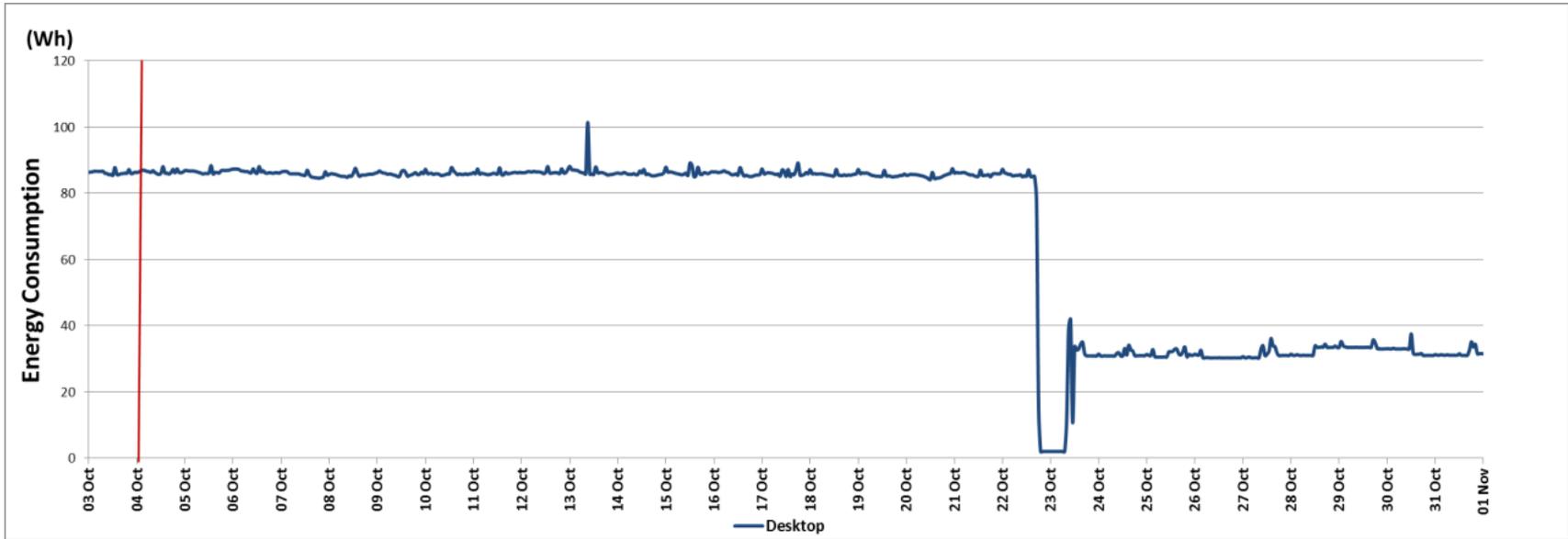


Diagnostic : Energy Saving Parameters had deficient settings, energy saver was working for the monitor but not the for CPU. The user believed her computer was in sleep mode as her monitor was in sleep mode.

Recommendation : Optimization of the CPU Energy Management Settings .

Savings : 70 % Energy Savings

Individual Actions



Diagnostic : This old computer was used as a server and needed to stay active all the time. This obsolete computer was using too much energy.

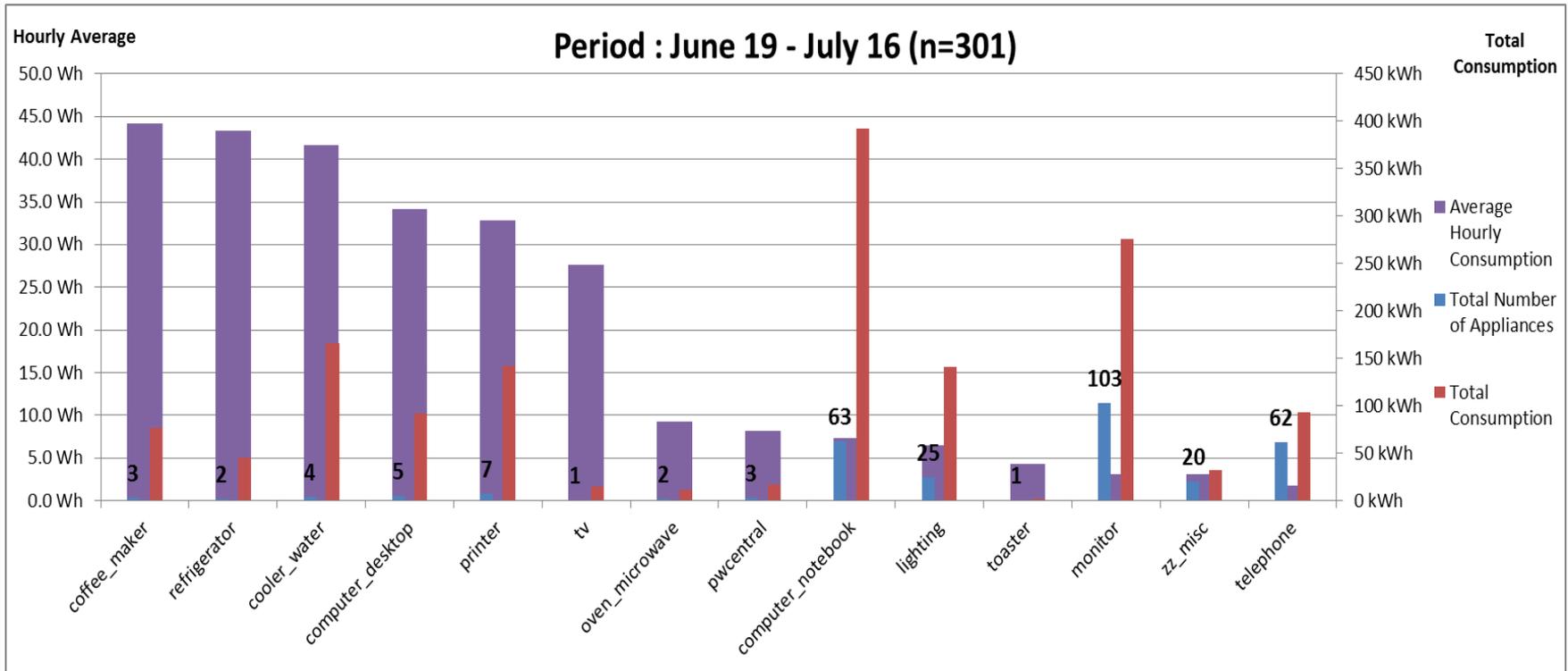
Recommendation : Change the computer with Top 10 Energy saving computer http://www.energystar.gov/index.cfm?fuseaction=find_a_product.

Savings : 60 % Energy Savings

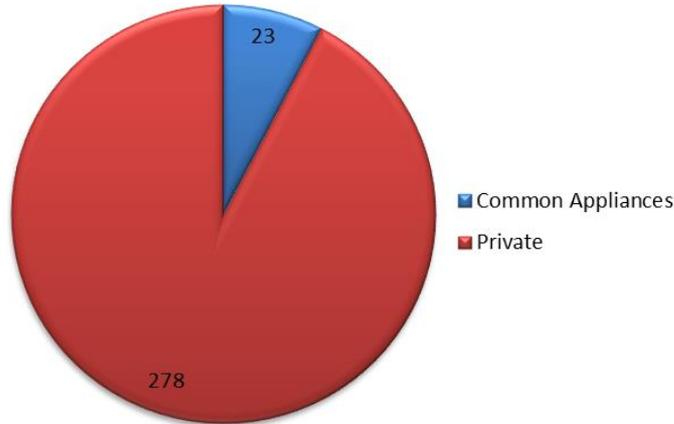


Refrigerator
Coffee Maker
Water Dispenser
Microwave
Toaster
Printer
Conf. Phone
TV
[25 common
appliances]

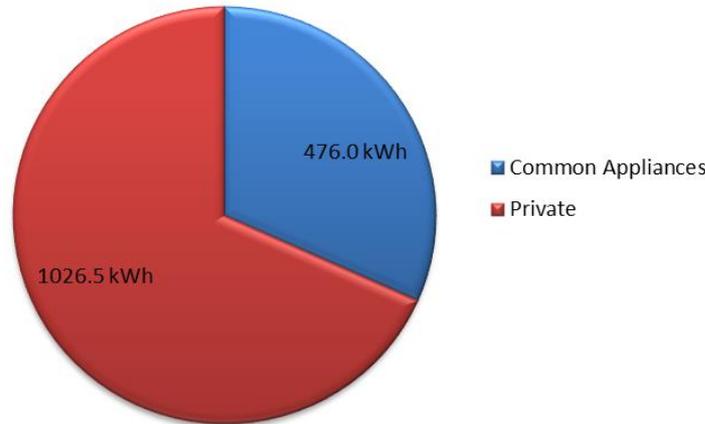
Appliance Energy Consumption

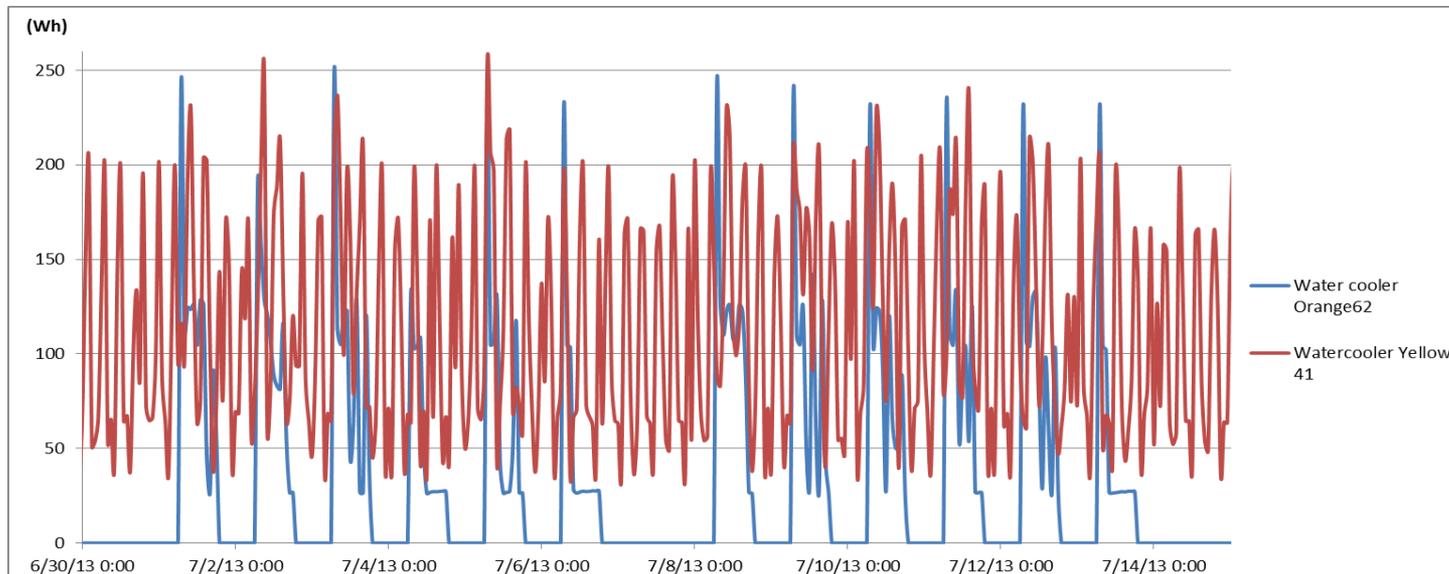
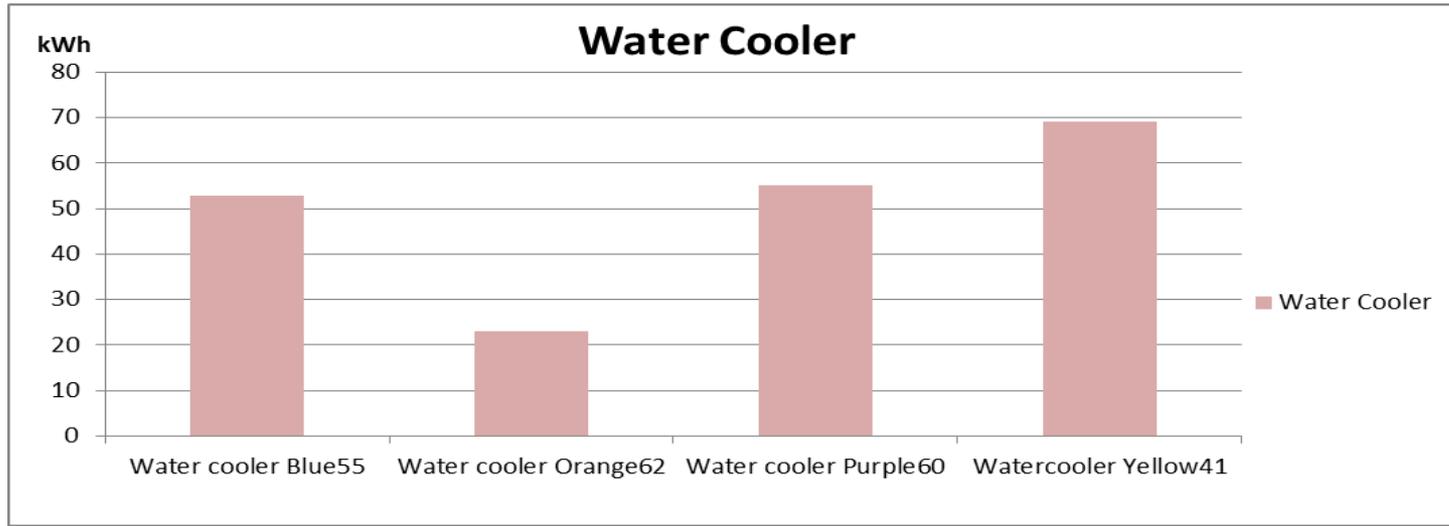


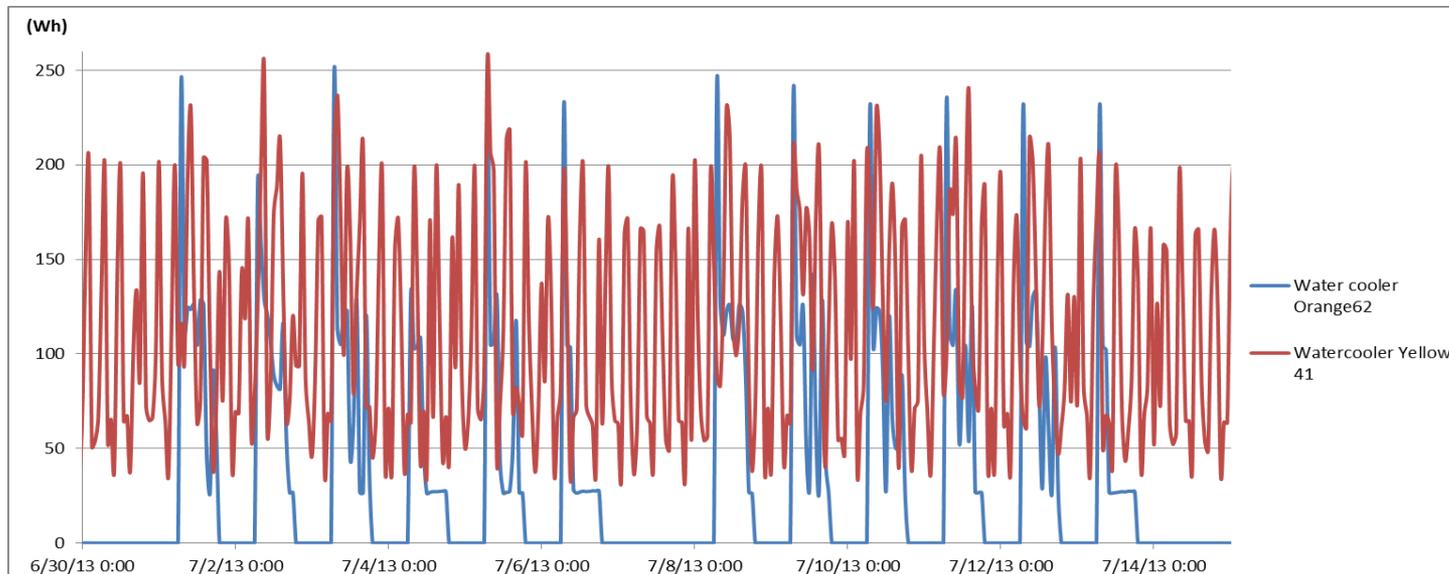
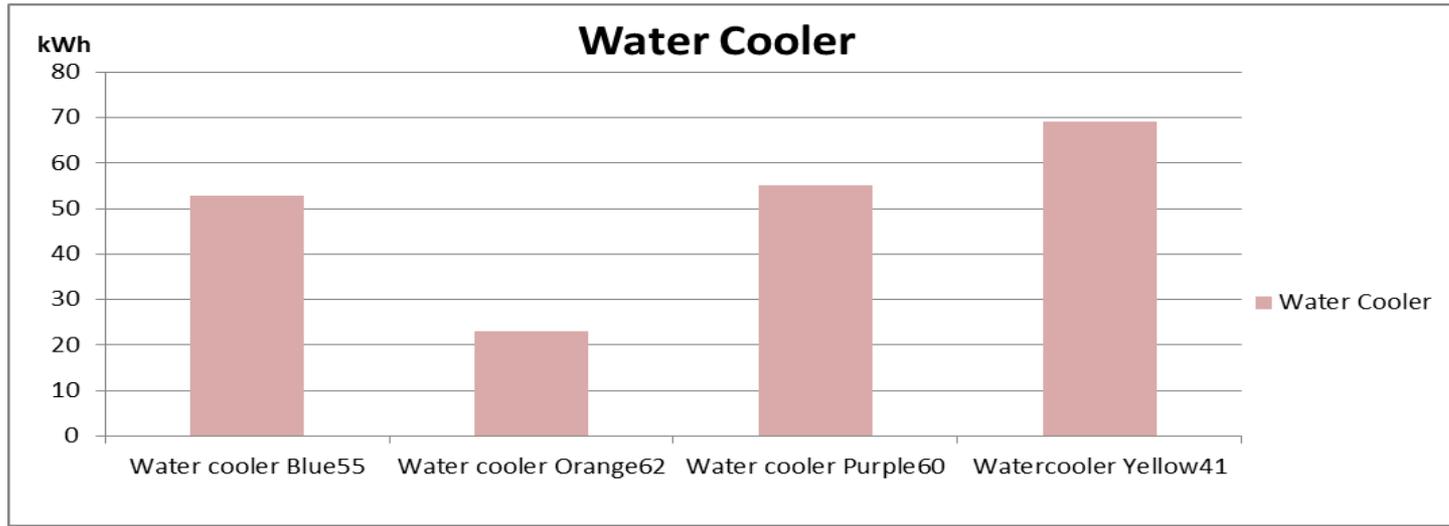
Number of Appliances



Consumption









Water Cooler

